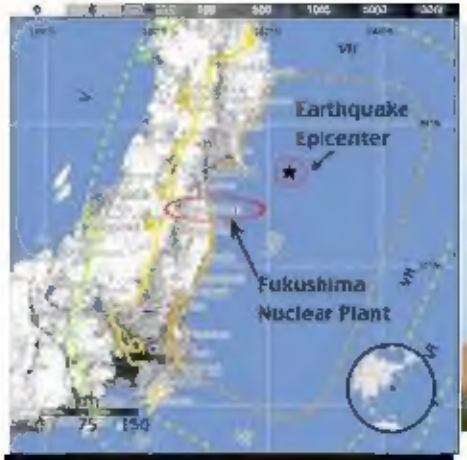
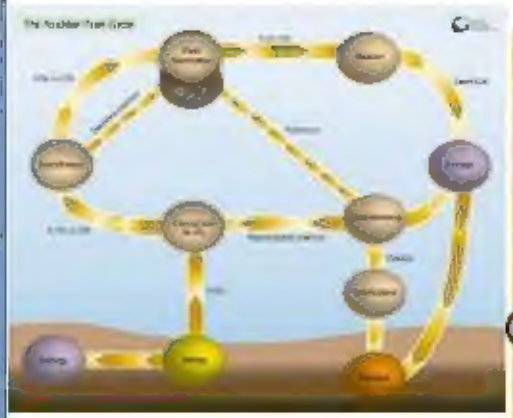
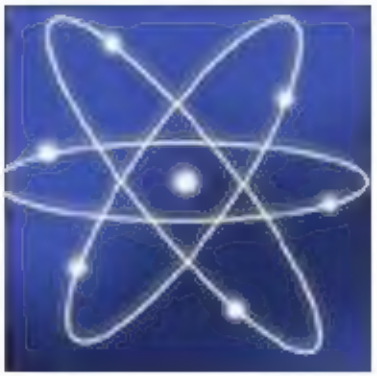
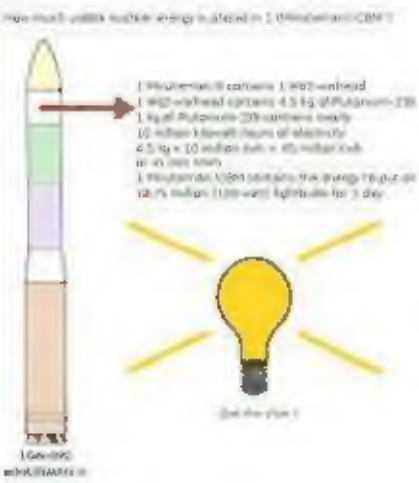


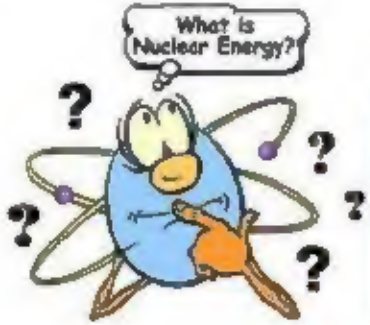


NUCLEAR ENERGY

FACTS, FACTS & MORE FACTS

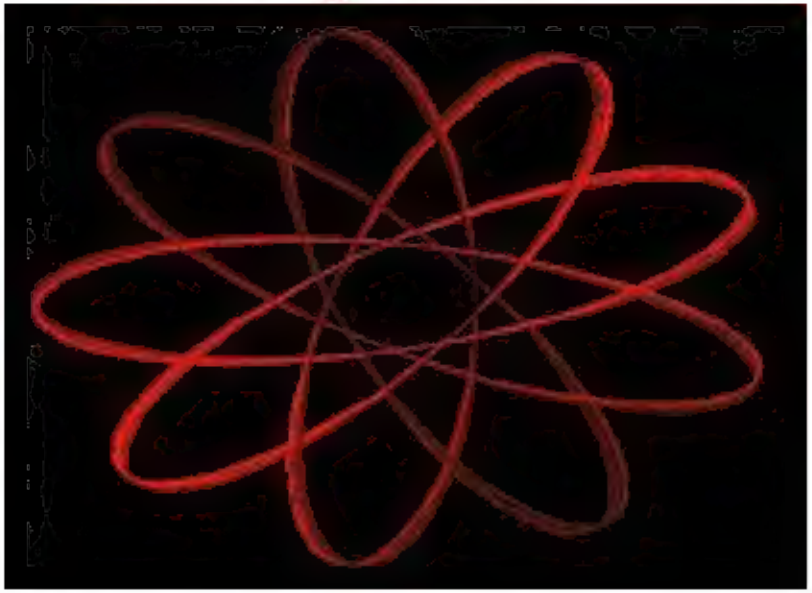


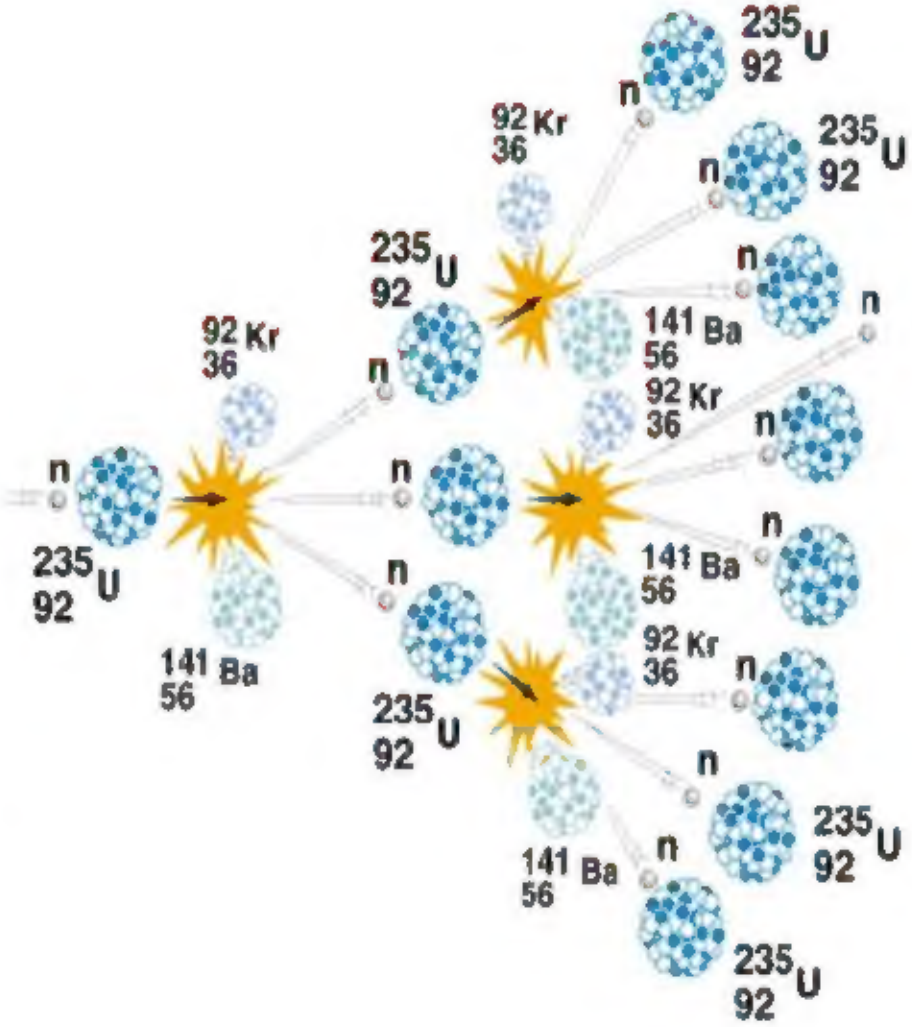




Nuclear Energy- the energy within the nucleus of an atom

- Nuclear fission – the splitting of the nucleus of a uranium atom releasing heat





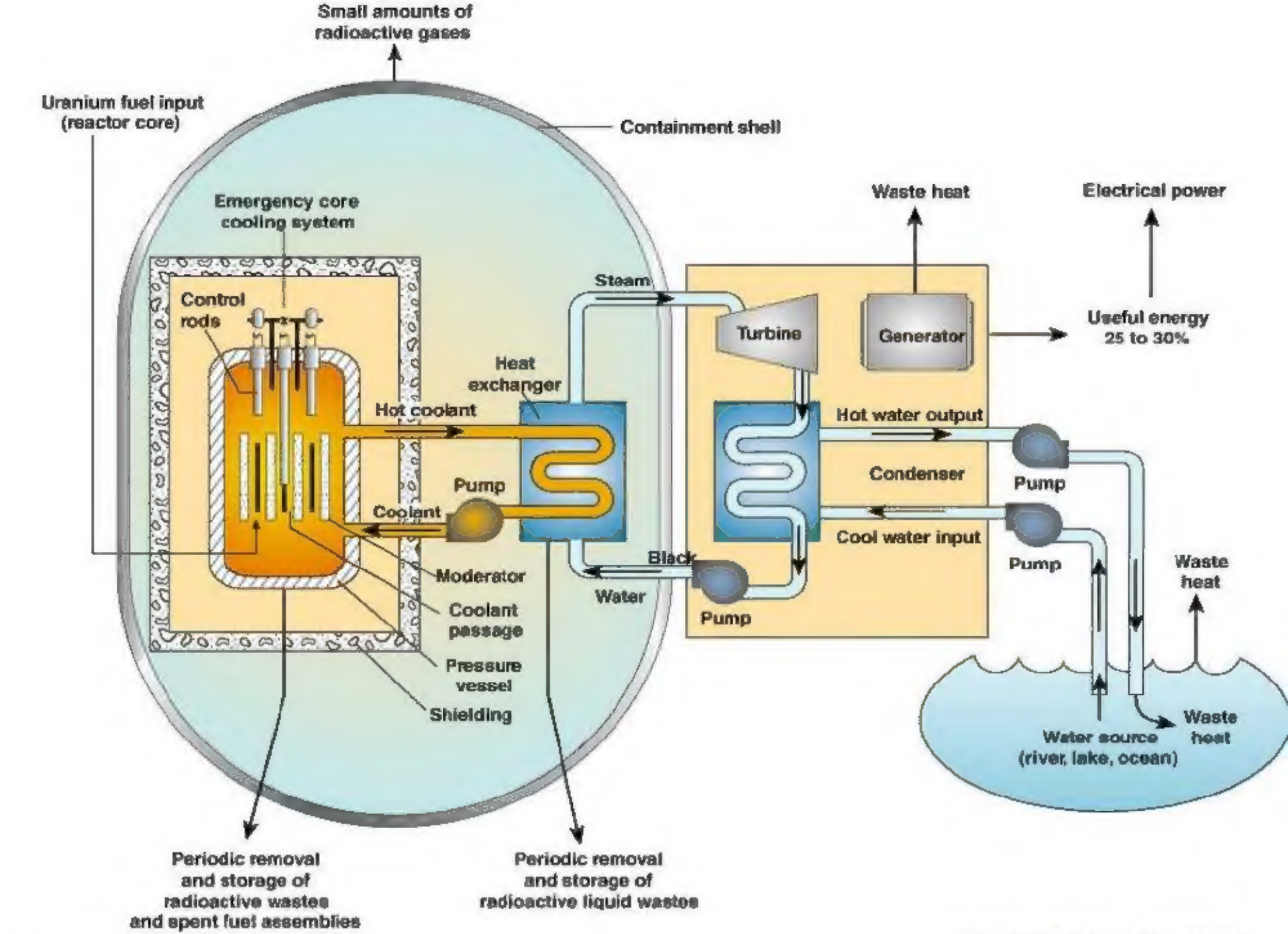
NUCLEAR ENERGY

- ADVANTAGES:
- LARGE FUEL SUPPLY
- LOW ENVIRONMENTAL IMPACT
- EMITS MUCH LESS CO2 THAN COAL
- LOW RISK OF ACCIDENTS
- MODERATE LAND DISRUPTION

- DISADVANTAGES
- HIGH COST
- LOW NET ENERGY YIELD
- HIGH ENVIRONMENTAL IMPACT IF ACCIDENT OCCURS
- CATASTROPHIC ACCIDENTS CAN OCCUR
- DISPOSAL OF SPENT NUCLEAR RODS/MATERIAL
- INCREASES KNOWLEDGE/TECHNOLOGY FOR NUCLEAR WEAPONS

Nuclear Energy/Nuclear Power Plants

- In a conventional nuclear power plant
  - a controlled nuclear fission chain reaction
  - heats water
  - produce high-pressure steam
  - that turns turbines &
  - generates electricity.



Radioactivity

- Radioactive decay continues until the the original isotope is changed into a stable isotope that is not radioactive
- Radioactivity: Nuclear changes in which unstable (radioactive) isotopes emit particles & energy

Radioactivity

- Types
  - *Alpha particles* consist of 2 protons and 2 neutrons, and therefore are positively charged
  - *Beta particles* are negatively charged (electrons)
  - *Gamma rays* have no mass or charge, but are a form of electromagnetic radiation (similar to X-rays)
- Sources of natural radiation
  - Soil
  - Rocks
  - Air
  - Water
  - Cosmic rays

Half-Life

The time needed for **one-half** of the nuclei in a radioisotope to decay and emit their radiation to form a different isotope

	Half-Life	**emitted**
Uranium 235	710 million yrs	alpha, gamma
Plutonium 239	24.000 yrs	alpha, gamma

During operation, nuclear power plants produce radioactive wastes, including some that remain dangerous for tens of thousands of years

Half-life

- The relative rate of decay of different radioactive isotopes is most easily described by comparing their half-lives. The half-life of a radioactive isotope is the amount of time needed for one-half of the atoms in a sample to decay into a stable element.
- EXAMPLE: Iodine-131 has a half-life of eight days.
- If you start with 32g of I-131, how much will you have after…
- …8 days? _____
- …16 days? _____
- …24 days? _____
- If you start with 100g of I-131, how long will it take until you only have 6.125g left?

Determining Half-Life

Strontium-90 is a radioactive isotope with a half-life of 29 years. Assume that 10,000 atoms of Sr-90 are generated in a nuclear reaction and then stored.

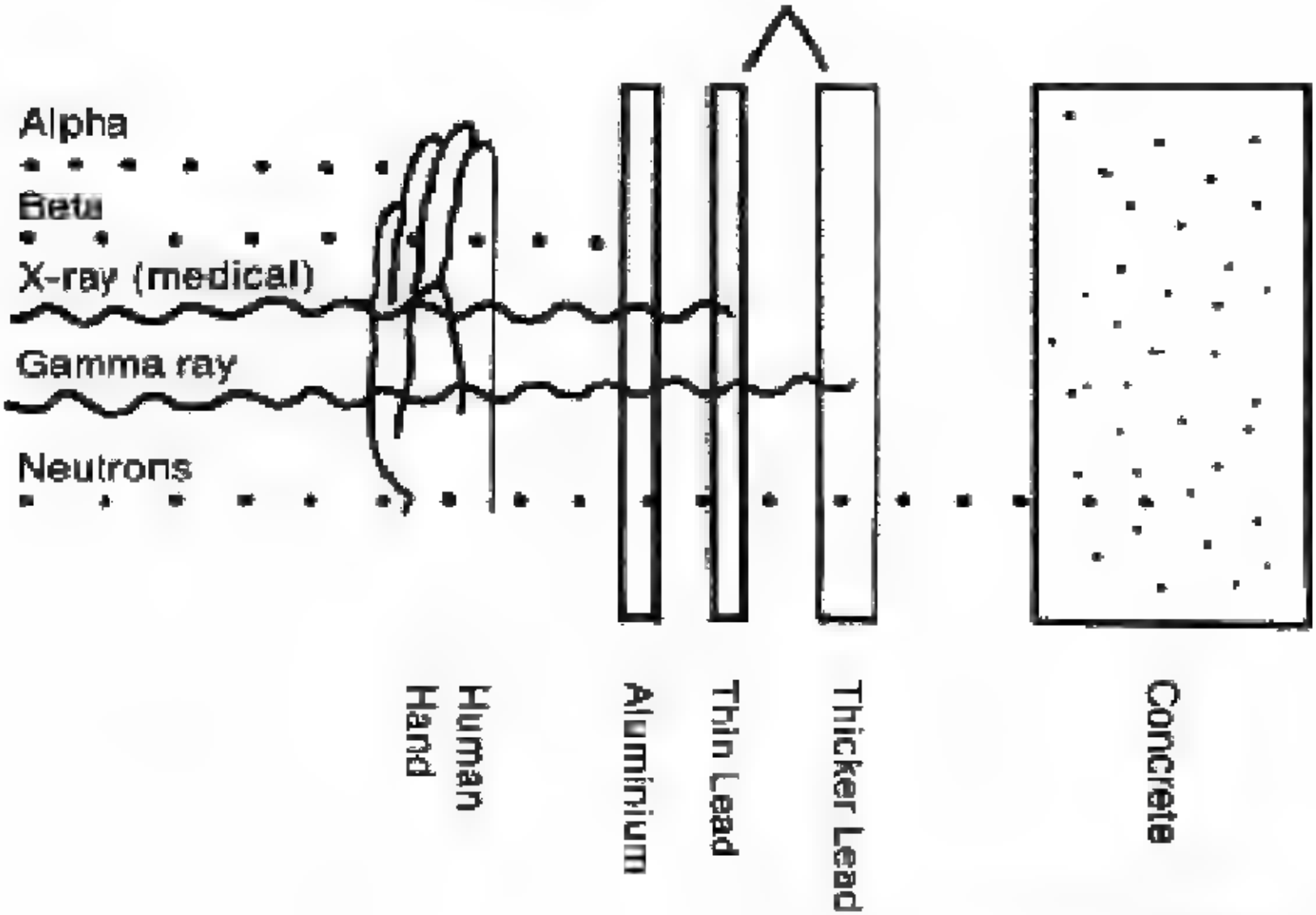
Complete the following table to determine how much time will have elapsed when 1250 atoms of Sr-90 remain in the storage facility.

# of half-lives	0	1	2	3	4	5
# of years						
# of Sr-90 atoms						

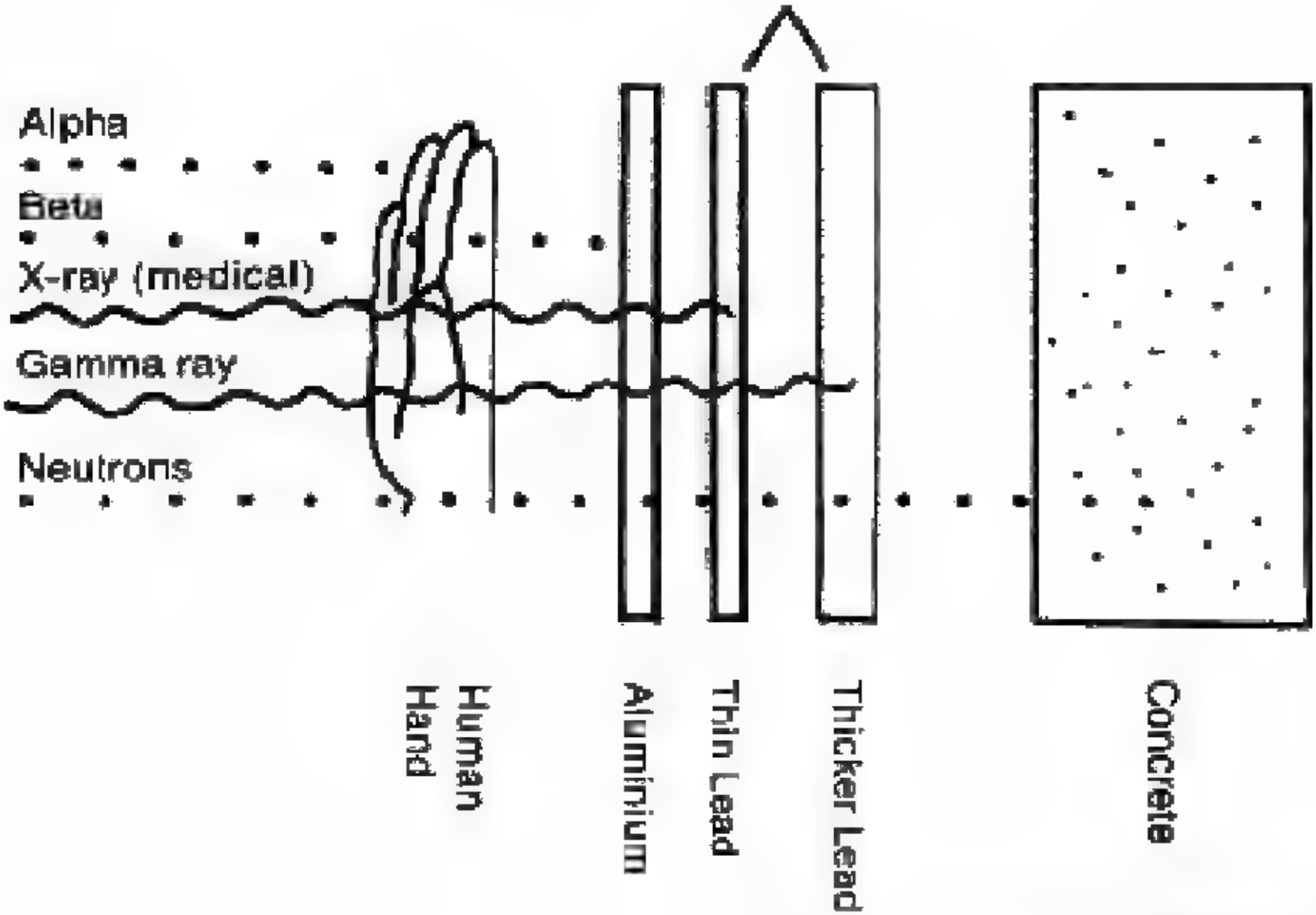
Effects of Radiation

- Genetic damages: from mutations that alter genes
- Genetic defects can become apparent in the next generation
- Somatic damages: to tissue, such as burns, miscarriages & cancers

Penetrating Power of Different Types of Radiation



Penetrating Power of Different Types of Radiation



Disposal of spent nuclear rods

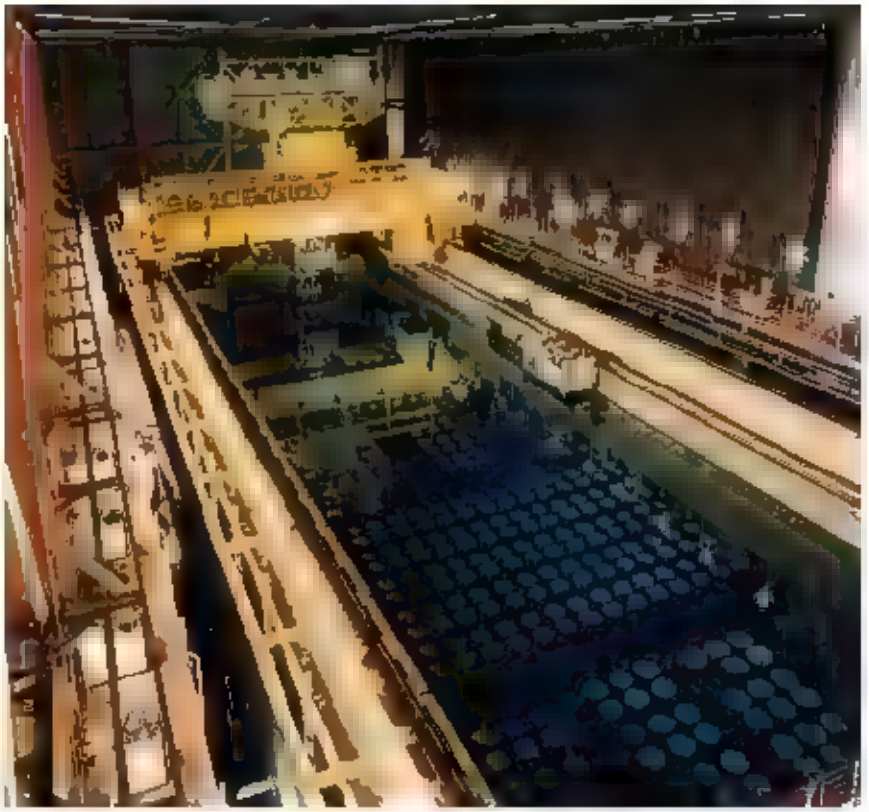
- When removed from the reactor core, the rods are extremely hot and must be cooled down. The spent rods are placed in a temporary storage pool to cool down. The pool is filled with boric acid, which helps to absorb some of the radiation given off by the radioactive nuclei inside the spent rods. The spent fuel rods are supposed to stay in the pool for only about 6 months, but, because there is no permanent storage site, they often stay there for years. Many power plants have had to enlarge their pools to make room for more rods. As pools fill, there are major problems. If the rods are placed too close together, the remaining nuclear fuel could go critical, starting a nuclear chain reaction. Thus, the rods must be monitored and it is very important that the pools do not become too crowded. Also, as an additional safety measure, neutron-absorbing materials similar to those used in control rods are placed amongst the fuel rods. Permanent disposal of the spent fuel is becoming more important as the pools become more and more crowded.

Disposal of Radioactive Waste

Most used fuel from nuclear power plants is stored in steel-lined concrete pools filled with water, or in airtight steel or concrete-and-steel containers as pictured.

- U S Power Plant

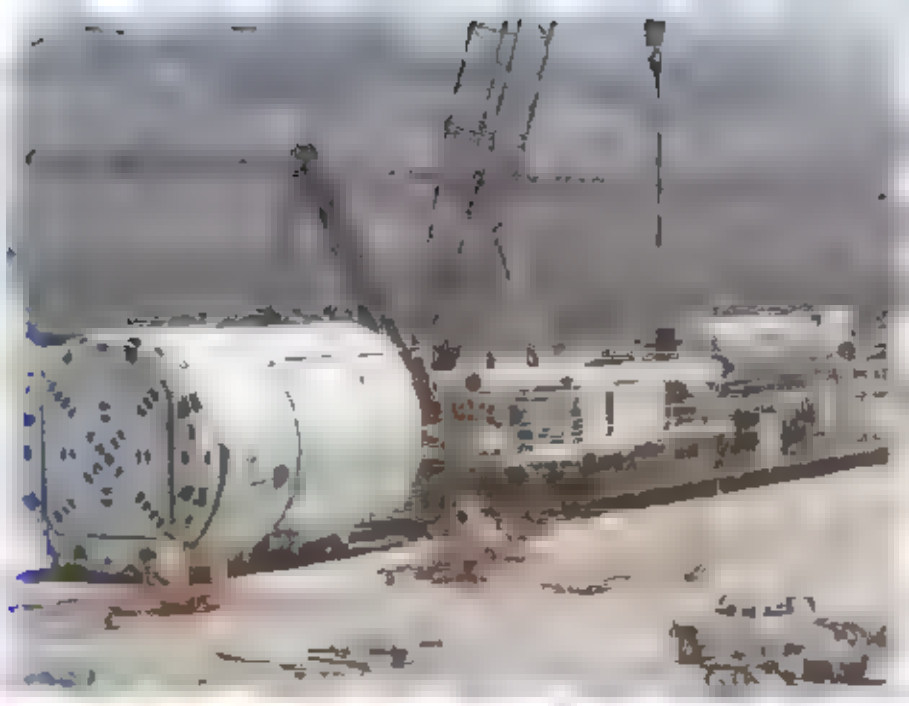
UK Power Plant

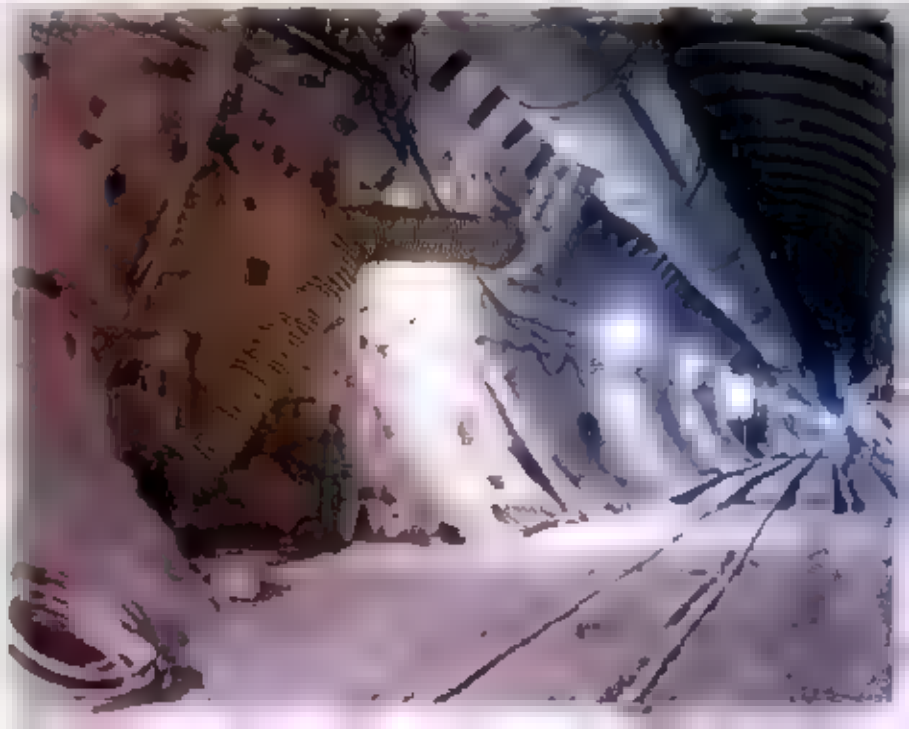


Radioactive Waste

1. **Bury it deep underground.**
   - *Problems*: i.e. earthquake, groundwater…
2. **Shoot it into space or into the sun.**
   - *Problems*: costs, accident would affect large area.
3. **Bury it under the Antarctic ice sheet.**
   - *Problems*: long-term stability of ice is not known, global warming
4. **Most likely plan for the US**
   - Bury it into Yucca Mountain in desert of Nevada
   - Cost of over $ 50 billion
   - 160 miles from Las Vegas
   - Transportation across the country via train & truck

Yucca Mountain





Advantages

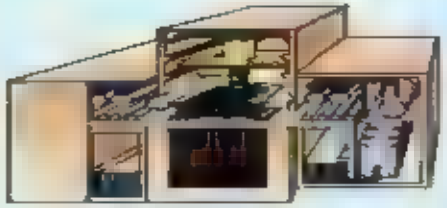
Large fuel supply

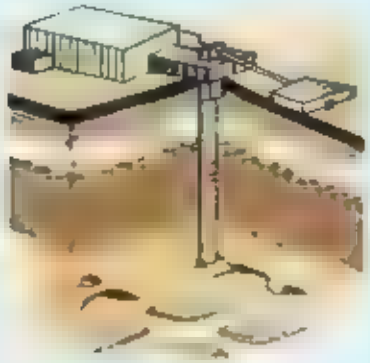
Low environmental impact (without accidents)

Emits 1/6 as much CO_2 as coal

Moderate land disruption and water pollution (without accidents)

Low risk of accidents because of multiple safety systems (except in 36 poorly designed and run reactors in former Soviet Union and Eastern Europe)





Disadvantages

High cost (even with large subsidies)

Low net energy yield

High environmental impact (with major accidents)

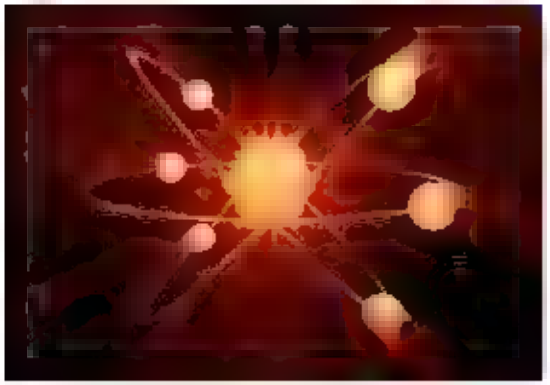
Catastrophic accidents can happen (Chernobyl)

No acceptable solution for long-term storage of radioactive wastes and decommissioning worn-out plants

Spreads knowledge and technology for building nuclear weapons

Nuclear Energy Accidents

- Accidents at Chernobyl and Three Mile Island showed that a partial or complete meltdown is possible



Three Mile Island

- March 29, 1979, a reactor near Harrisburg, PA lost coolant water because of mechanical and human errors and suffered a partial meltdown
- 50,000 people evacuated & another 50,000 fled area
- Unknown amounts of radioactive materials released
- Partial cleanup & damages cost $1.2 billion
- Released radiation increased cancer rates.

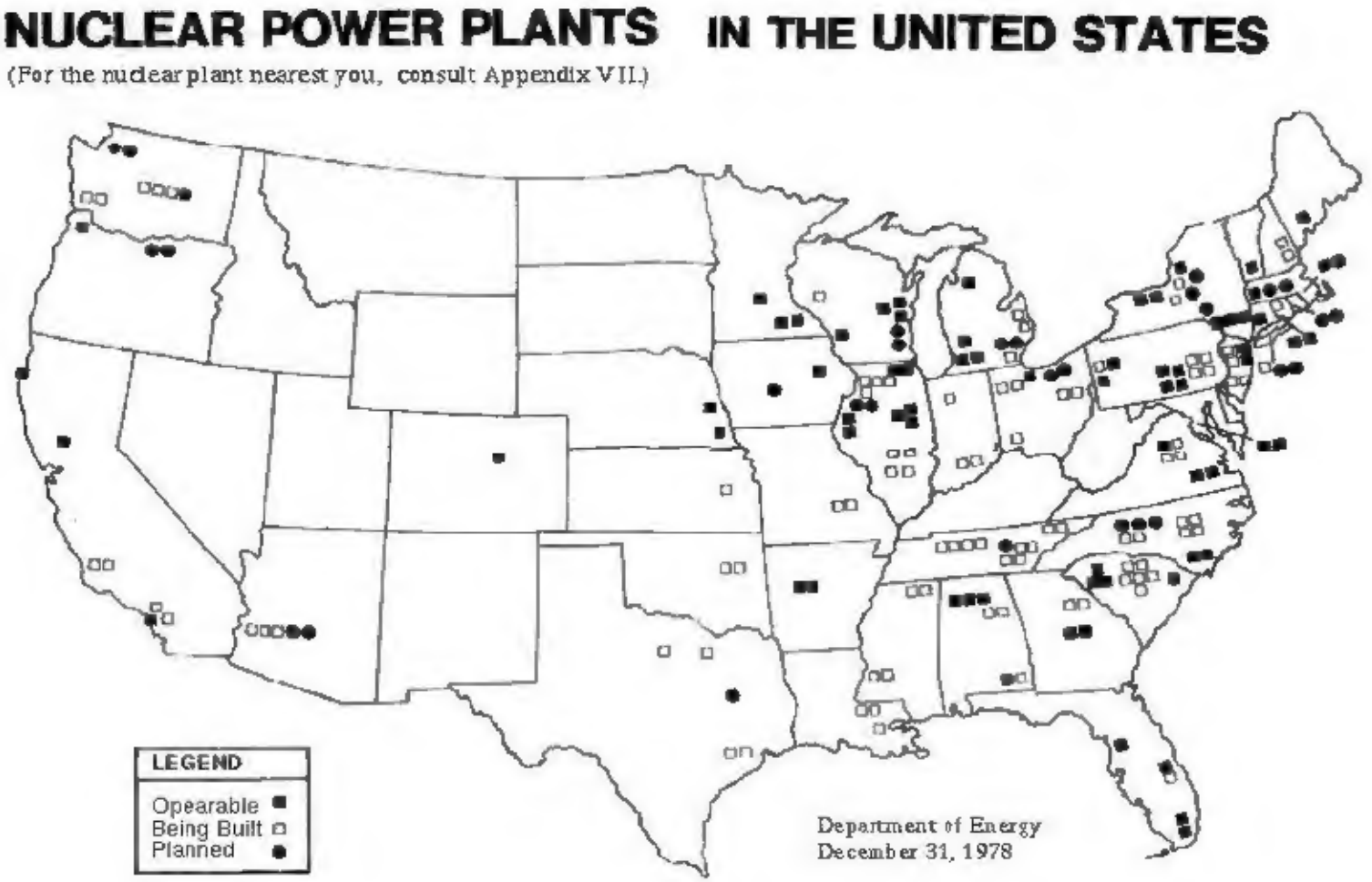
Three Mile Island

nuclear accident

Chernobyl

- April 26, 1986, reactor explosion (Ukraine) flung radioactive debris into atmosphere
- Health ministry reported 3,576 deaths
- Green Peace estimates 32,000 deaths;
- About 400,000 people were forced to leave their homes
- ~160,000 sq km (62,00 sq mi) contaminated
- > Half million people exposed to dangerous levels of radioactivity
- Cost of incident > $358 billion

Locations of Nuclear Power Plants



World Locations of Nuclear Power Plants